Update

Space Based ADS-B

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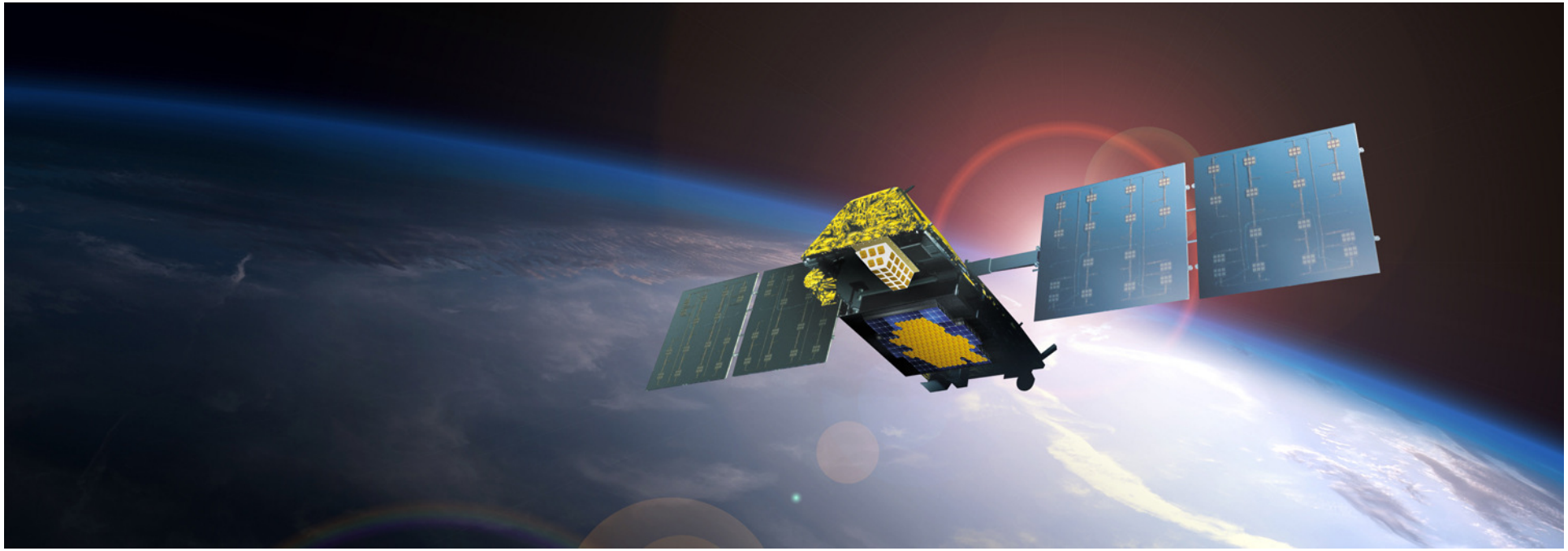
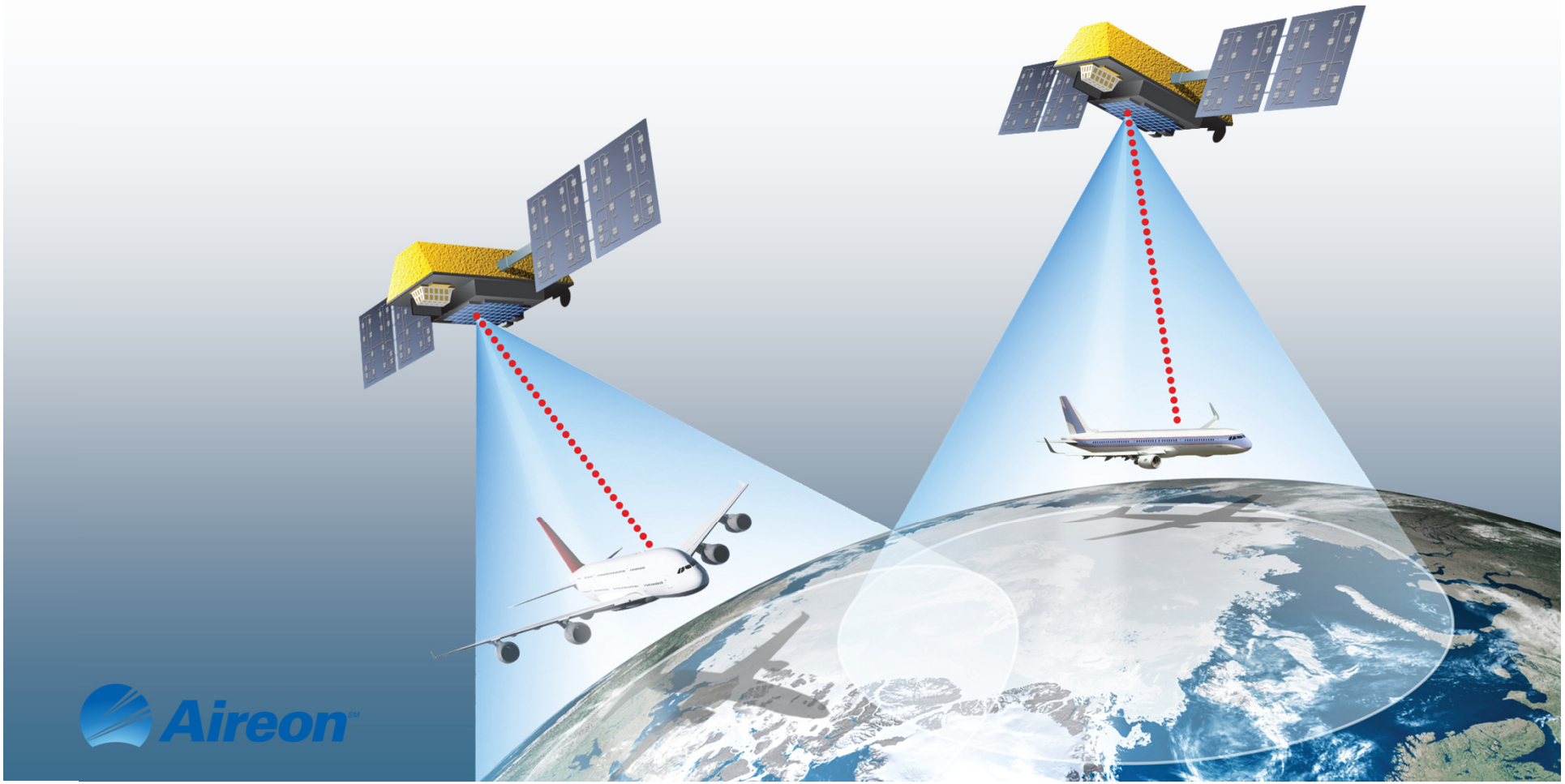
Aireon℠



- Aireon LLC is a joint venture between Iridium Communications Inc., NAV CANADA, ENAV of Italy, the Irish Aviation Authority and Naviair of Denmark
- The goal of this initiative is to reduce aircraft separation minima through ADS-B (out) via Low Earth Orbiting (LEO) satellites

LEO Satellites –
Extending Air Traffic Surveillance



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Aireon℠ A Transformative Solution

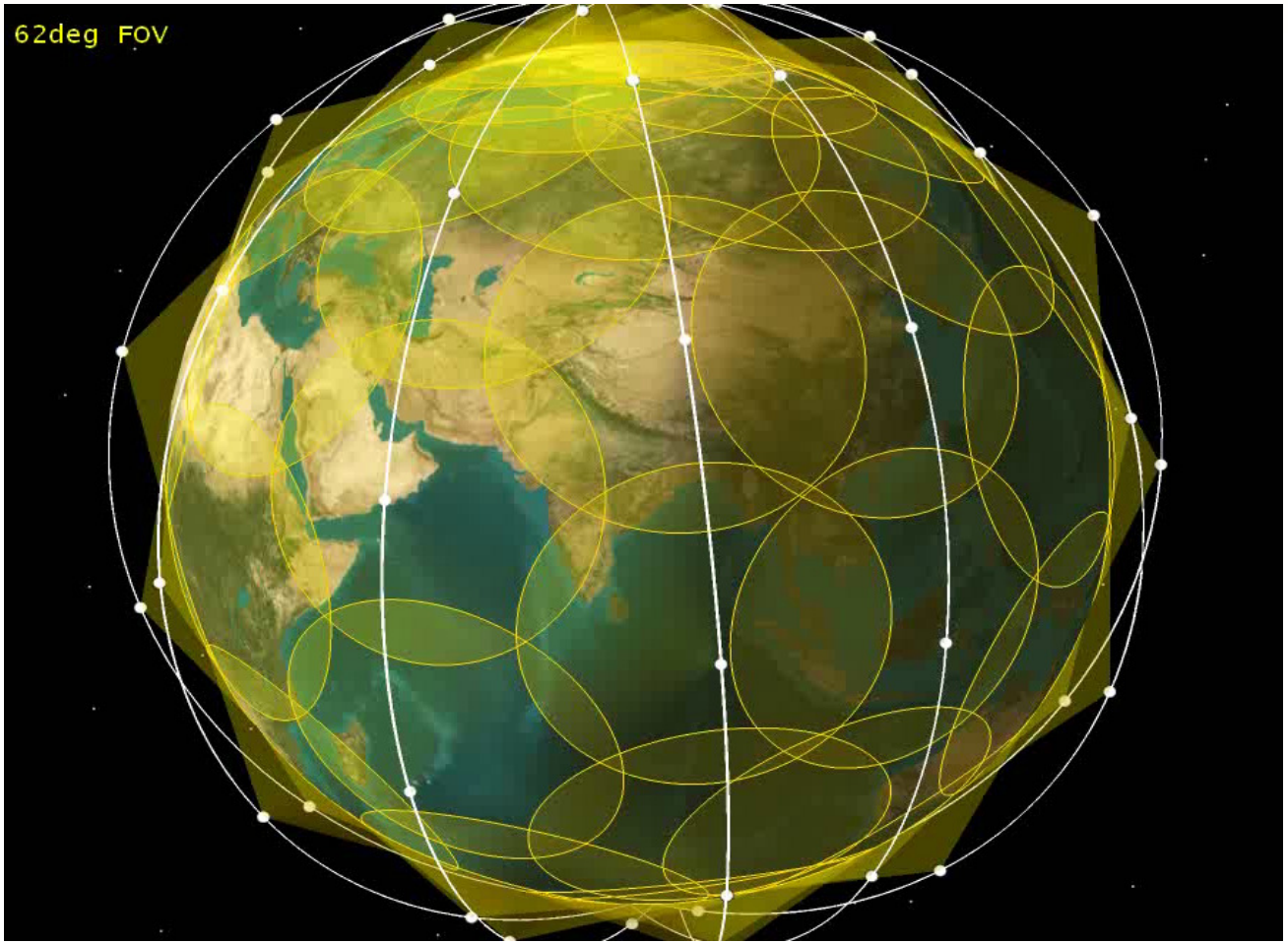
Estimated current global surveillance coverage

Global surveillance coverage before Aireon

Aireon global coverage

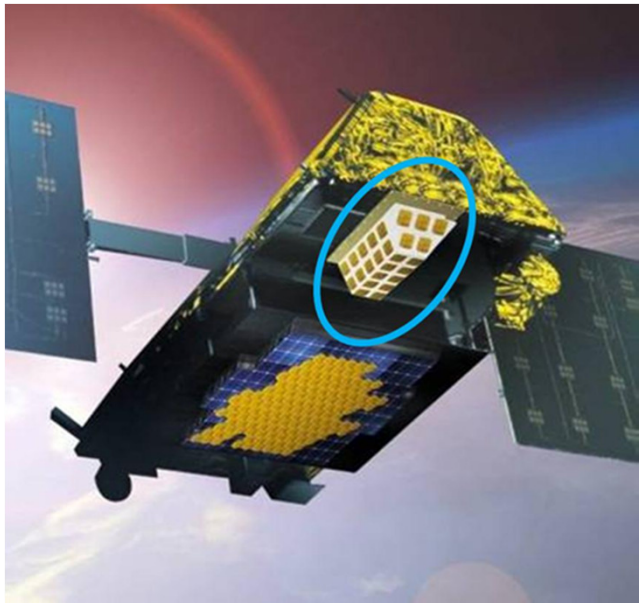
Global surveillance coverage after Aireon

Constellation of 66 LEO Satellites

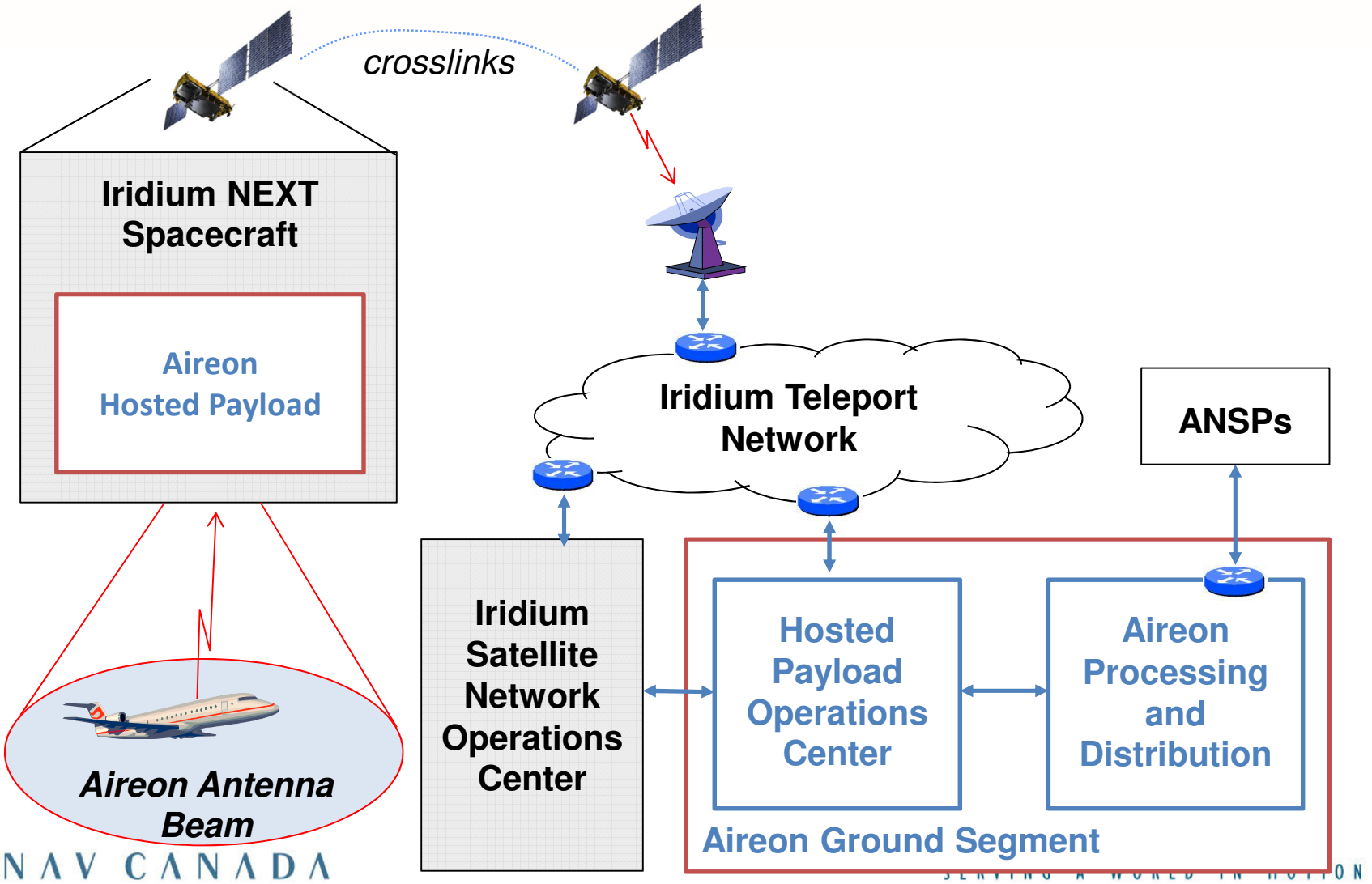


Orbit Characteristics

- 6 orbital planes of 11 satellites
- Near-polar orbit at 780 km altitude
- Orbit period ~100 minutes
- Ground speed ~24,000 km/h
- An aircraft will be in view of a given satellite for no more than 10 minutes
- Ground tracks of satellites are not fixed
  - Next in-trail satellite track ~2.5 degrees west



Aireon System Overview



Expected Performance

- Aireon System performance testing validates ability to support reduced oceanic and terrestrial separation standards
- Position reports with Update Intervals ≤ 8 - 15 seconds (95%)
- dependent on avionics transmit power and geographic latitude/location
- Low Latency ≤ 2.5s to ATC Surveillance Tracker
- Space Based ADS-B is another form of ATS surveillance
- High availability design uses system redundancy and cross-linked communications backbone
- 99.9% continuous global availability to ICAO GOLD Standard

Aireon facilities

Aireon℠ Benefits

- First ever complete pole-to-pole coverage
- Estimated annual fuel savings of $100 million for North Atlantic
- Enhanced safety and decreased congestion
- Increased air operations capacity and efficiency
- Reduced emissions and environmental impact

Aireon℠ ALERT Service

Aircraft Locating and Emergency Response Tracking

- Service available free-of-charge
- Location and last flight track of missing ADS-B-equipped aircraft accessed by Rescue agencies and Air Navigation Service Providers

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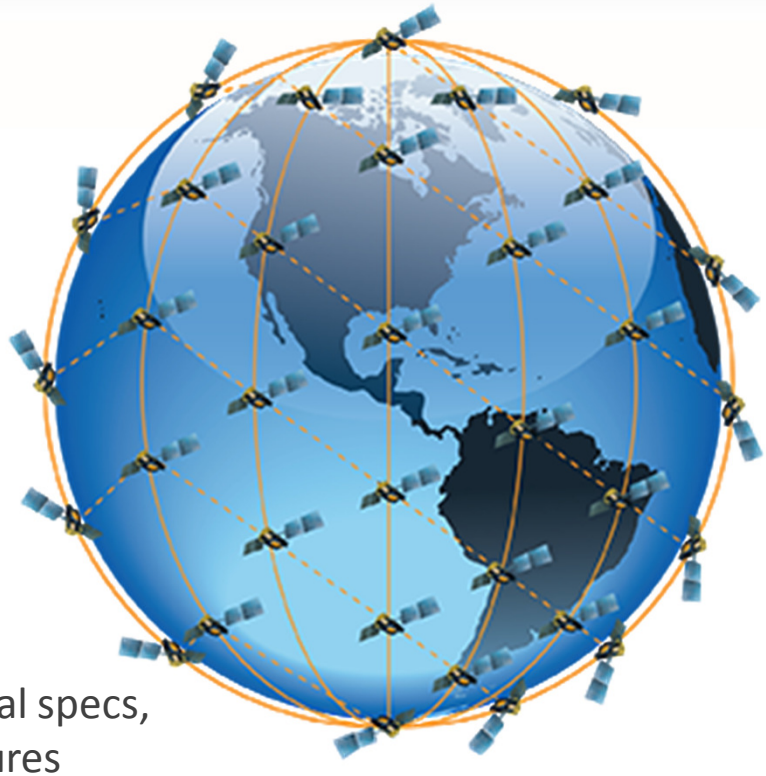
Aireon℠ Status

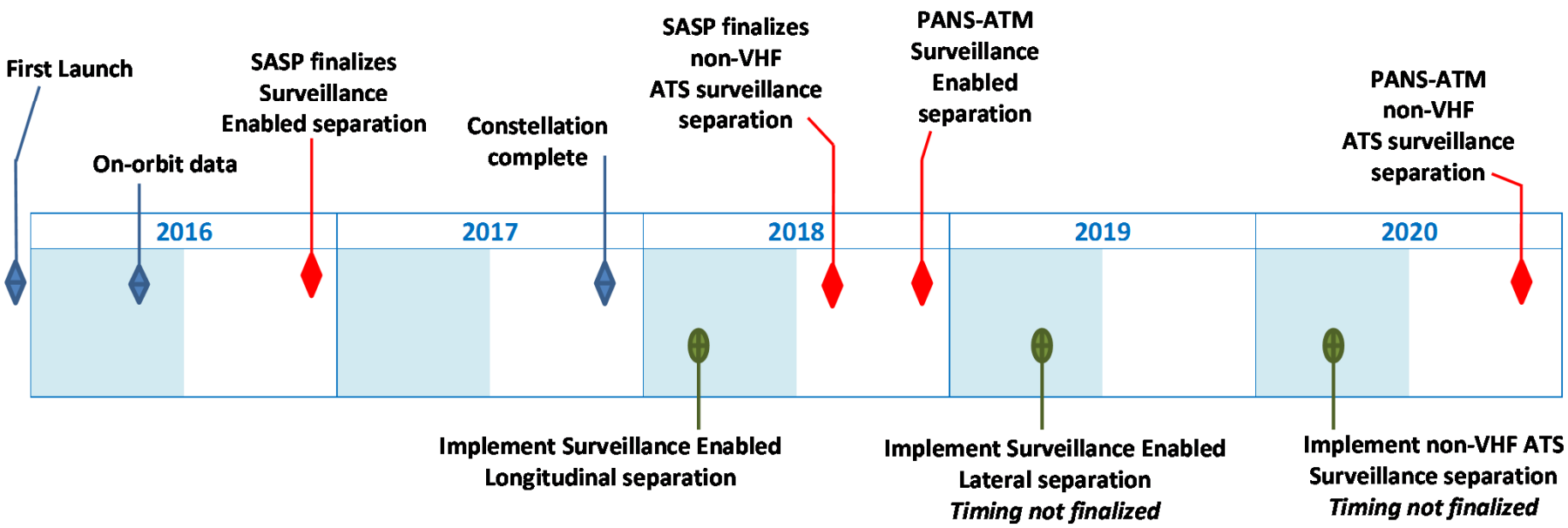


- Advisory Committee struck (IATA, Airlines and ANSPs)
- Customer data service agreements with NAV CANADA, NATS, ENAV, Naviair, and IAA, MOU with NAV Portugal, the Civil Aviation Authority of Singapore and Blue Med Functional Airspace Block (FAB), MOA with the Agency for the Security of Aviation Navigation in Africa and Madagascar (ASECNA)
- NAV CANADA/FAA collaboration on technical specs, policies, standards and operational procedures
- ADS-B payload has passed space qualification tests and is in production
- Iridium NEXT satellite constellation to launch 2015-2017
- Service to commence in 2018

Collaborative NAT implementation

- NATS and NAV CANADA joint planning
- NATS consultation and approval process on-going
- Develop once, use twice
  - ATC CONOPS
  - System Requirements
  - Safety Management
  - Human Factors and Training analyses
- Initial implementation: surveillance enabled separation
  - reduced procedural separation based on ATS surveillance for position updates and conformance monitoring
- Evolution to non-VHF ATS surveillance separation

Timeline overview



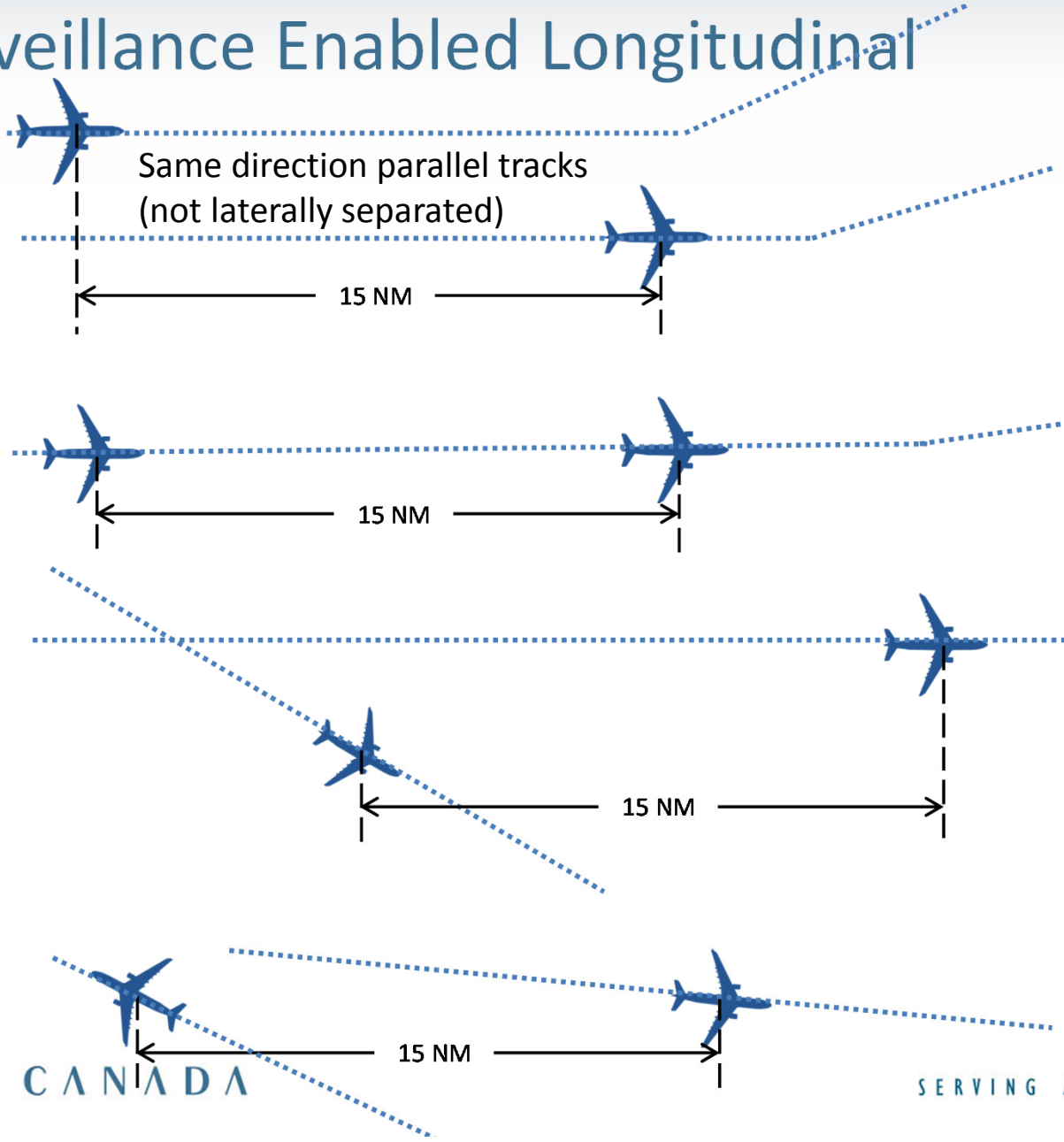
Development of Global Provisions (1)

- Space-Based ADS-B is an ATS surveillance system
  - Technical assessment will be completed as described in Circular 326 *Assessment of ADS-B and Multilateration Surveillance to Support Air Traffic Services and Guidelines for Implementation*
- ATS surveillance minima already established for VHF Direct Controller Pilot Communications (DCPC) environments
- ICAO Separation and Airspace Safety Panel (SASP) has completed Job Card and Operational Requirements to support Space-Based ADS-B
- Surveillance and Communications performance will be specified (RSP and RCP)

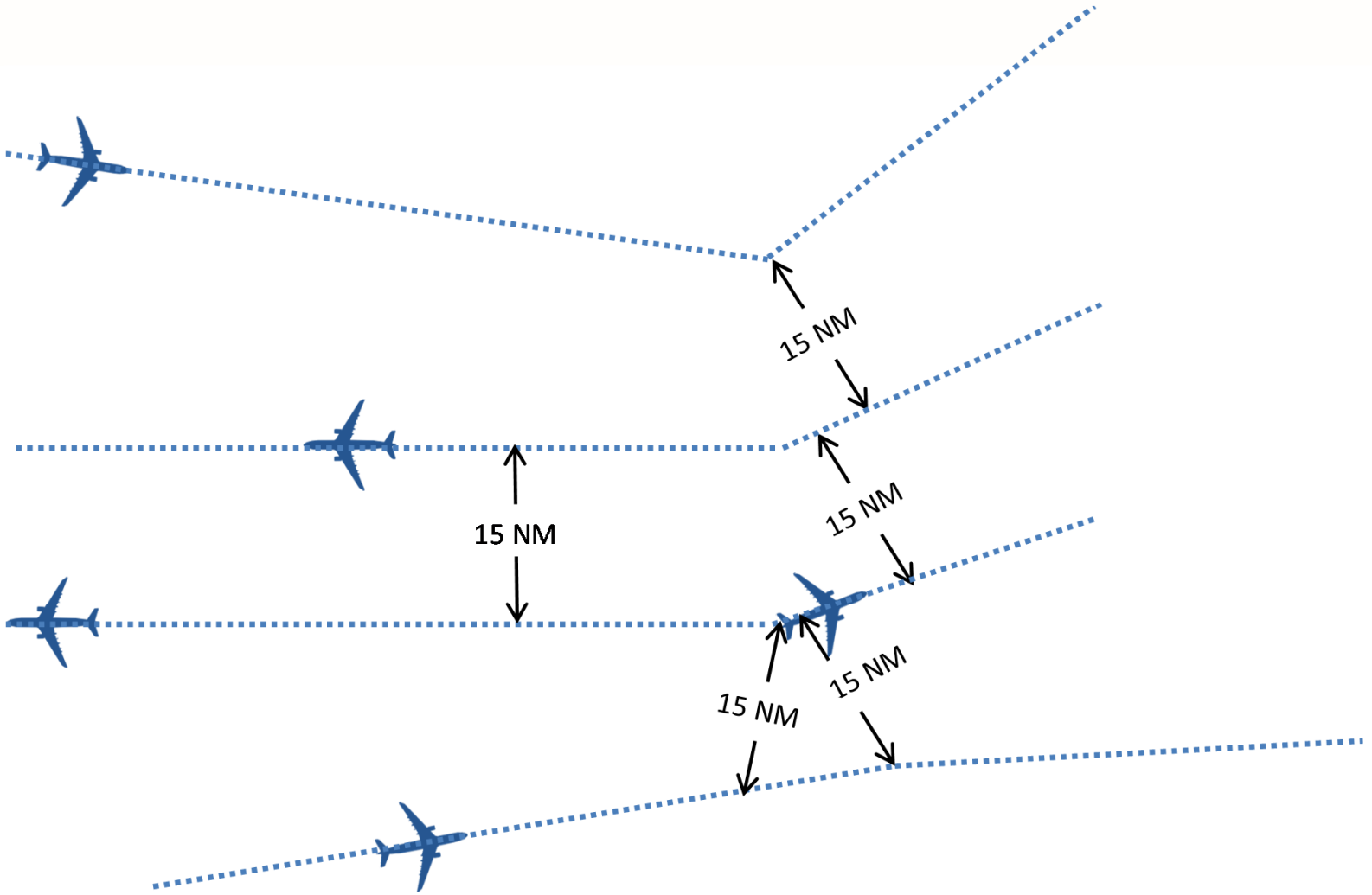
Development of Global Provisions (2)

- Space-based ADS-B used for longitudinal and lateral separation in procedural airspace (surveillance enabled separations)
  - Collision Risk Model (CRM) presented to SASP Mathematical Sub-Group in May 2015
  - Refined CRM to SASP in November 2015
  - Proposed separation standards finalized by November 2016
  - SASP proposal to ICAO Air Navigation Commission (ANC) in 2017
  - Expected PANS-ATM (Doc 4444) publication in November 2018
- Space-based ADS-B to provide ATS surveillance separation (ATS surveillance minima for non-VHF DCPC environments)
  - CRM under development
  - Interdependency on RCP being established for SATVOICE
  - Planning for PANS-ATM publication in November 2020

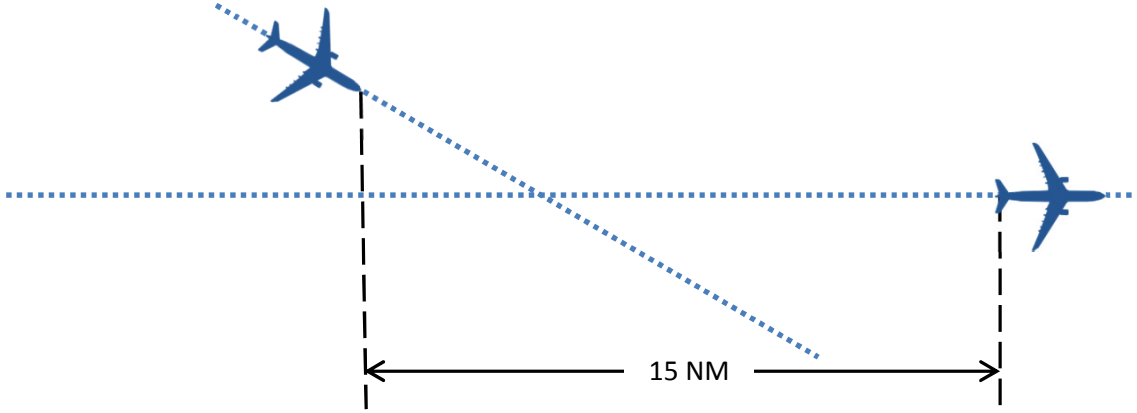
Surveillance Enabled Longitudinal



Surveillance Enabled Lateral



Surveillance Enabled Intersecting



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THANK YOU